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U. S. DEPARTMENT OF AGRICULTURE,
OFFICE OF EXPERIMENT STATIONS,

A. C. TRUE, DIRECTOR.

ANNUAL REPORT OF THE HAWAII AGRICULTURAL
EXPERIMENT STATION FOR 1902.

BY

JARED G. SMITH,
Special Agent in Charge.

[Reprint from Annual Report of the Office of Experiment Stations for
the year ended June 30, 1902.]

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CONTENTS.

	Page.
Introduction	309
Publications	309
Experiments with taro rot	310
Grazing investigations	311
Potato-blight experiments	312
Coffee	313
Fiber plants	314
Sisal	314
Malina	315
Olona	315
Olona fiber	316
Manufacture	317
Fruits	318
Pineapples	318
Figs	319
Papayas	320
Guavas	320
Mangoes	321
Alligator pear	321
Grapes	321
Limes	321
Peanuts	322
Abandoned industries which deserve attention	322
Cotton	322
Castor bean	322
Pia, or cassava starch	322
Entomological investigations	323
Distribution of seeds	326
Correspondence	326
Work for other departments	326
Irrigation	326
Collections	327
The Farmers' Institute of Hawaii	327
Climate	329
Rainfall	329
Winds	330
Temperature	330

ILLUSTRATIONS.

	Page.
PLATE XX. Fig. 1.—Hawaii Station, new dwelling. Fig. 2.—Hawaii Station, a forest clearing, South Kona.....	310
XXI. Hawaii Station, taro plantations near Honolulu.....	310
XXII. Fig. 1.—Hawaii Station, taro recently planted. Fig. 2.—Hawaii Station, part of 600-acre sisal plantation.....	310
XXIII. Fig. 1.—Hawaii Station, registered Shorthorn cow, Punwaawaa ranch. Fig. 2.—Hawaii Station, wild cattle, Molokai.....	312
XXIV. Fig. 1.—Hawaii Station, bananas. Fig. 2.—Hawaii Station, alli- gator pears.....	320
XXV. Fig. 1.—Hawaii Station, orchard plantation, station grounds. Fig. 2.—Hawaii Station, 3-year-old lemon tree, Punwaawaa ranch	320
XXVI. Fig. 1.—Hawaii Station, cotton plats. Fig. 2.—Hawaii Station, castor-bean tree, 25 years old	322
XXVII. Fig. 1.—Hawaii Station, new plant house, muslin covered. Fig. 2.—Hawaii Station, interior of new plant house, showing con- struction	322

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By JARED G. SMITH, *Special Agent in Charge*

INTRODUCTION.

During the period from July 1, 1901, to June 30, 1902, an endeavor was made to place the Hawaii Agricultural Experiment Station on a working basis. During the short period between my arrival in Honolulu, early in April of the previous fiscal year, and the close of that year (June 30, 1901) but the barest commencement had been made. The buildings intended for laboratory, office, and residence were only partially completed, so that the first half of the fiscal year 1902 was devoted entirely to finishing the actual construction of buildings and permanent improvements. No additions to the list of structures mentioned in my annual report for 1901 were made, but much labor was utilized in grading, road making, and the preparation of land for cultivation experiments.

Considerable sums were expended in securing books and periodicals for a library. As a nucleus I have donated to the station my own private library of botanical and agricultural literature, amounting to about 2,000 books and pamphlets. These, with the books and periodicals purchased for the station and those supplied by the Department of Agriculture, make a fairly good working library, especially strong along the lines of systematic and economic botany and tropical agriculture. There is also a good series of bulletins from the State experiment stations and the United States Department of Agriculture. A considerable number of works relating to Hawaii have also been secured. A card index of literature in our library is being prepared so that the collection, while small, will be readily available to workers.

PUBLICATIONS.

A paper relating to "sore head" and other diseases of chickens in Hawaii, prepared by my assistant, T. F. Sedgwick, was published as Bulletin No. 1 of this station. About 2,000 copies have been distributed in the Territory. Sore head is a disease common to poultry, not only in Hawaii, but in many other tropical lands, as well as in Florida and California. It is a skin disease of fungus origin. Eruptions form on

the head of the fowl and spread until the ears, nostrils, and eyes are closed by a crust or scab, so that the birds become blind. The disease is fatal to young chickens, and has much to do with the high price of poultry in these islands. Preventive treatment consists in hygienic measures, cleanliness of runs and houses, good food, pure water, and destruction of lice and other parasites. These are but precautionary. When fowls become infected with sore head they may be cured by washing with warm soap and water, followed by antiseptics, such as permanganate of potash, carbolated vaseline, kerosene oil, and others. Other common diseases, such as roup, gapes, cholera, and intestinal worms, were described and remedies given.

EXPERIMENTS WITH TARO ROT.

As stated in my previous report, an experiment was undertaken to determine the nature of a disease of wet-land taro which is quite prevalent and destructive, especially on the island of Oahu, and remedial treatments for it. Taro is the staple food plant of the native Hawaiian. It is a marsh or aquatic plant which has been so long cultivated in tropical countries that, like the banana, sweet potato, and many other crops, it has apparently lost the power of propagating itself by seed. As a result of this artificial or specialized condition, and also because this crop has been grown for generations upon the same fields, without rotation of crops, fertilization of the soil, or the introduction of new strains or varieties, much of the Hawaiian taro has become constitutionally weak and subject to disease.

Taro is the chief food plant of the Hawaiians, and the industry in Hawaii represents an investment of fully \$500,000, and the annual sales amount to more than \$100,000. Furthermore, it is a crop for which no substitute has been found. All parts of the plant are eaten. The root is used as a vegetable; for making Taro-ena, a health food of much value for invalids; and poi, the national Hawaiian food. The leaves are eaten like spinach; the leafstalks like chards or asparagus, and the cooked flowers are highly esteemed as a vegetable of extremely delicate flavor. The refuse portions of the root, not used in poi manufacture, are utilized for fattening pigs.

In the vicinity of Honolulu and in many other localities on Oahu and Kauai where the lowland taro is cultivated a disease has recently become prevalent known as "root rot." In some kuhlianas, or taro patches, the root rot destroys from 50 per cent to 80 per cent of the crop. It has become so serious in some localities that the land is now devoted to the less remunerative rice cultivation. Good taro land with water rights is worth from \$500 to \$1,500 per acre, but if the taro root rot is prevalent the land becomes less valuable.

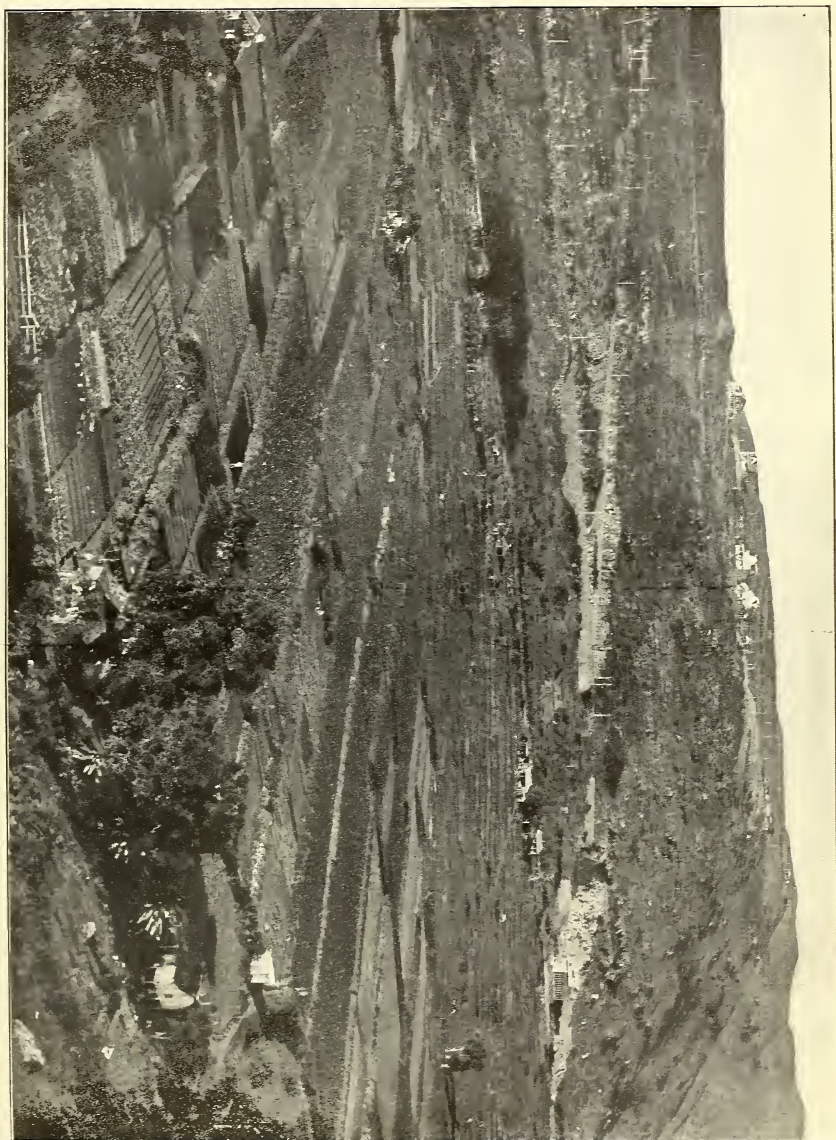
For the purpose of studying the nature of this disease and the methods to be adopted for its cure or prevention, a taro patch consist-



FIG. 1.—HAWAII STATION—NEW DWELLING.



FIG. 2.—HAWAII STATION—A FOREST CLEARING, SOUTH KONA.



HAWAII STATION TARO PLANTATIONS NEAR HONOLULU.

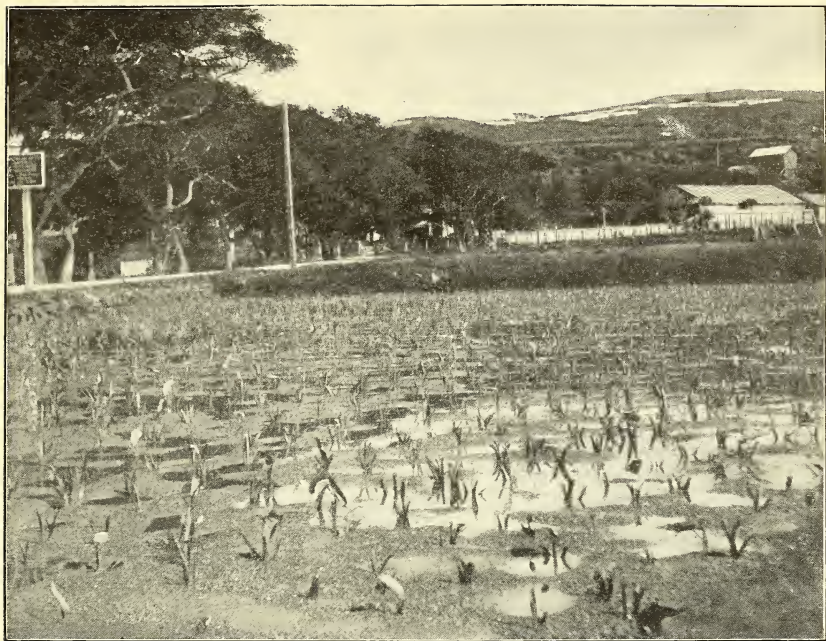


FIG. 1.—HAWAII STATION—TARO RECENTLY PLANTED.

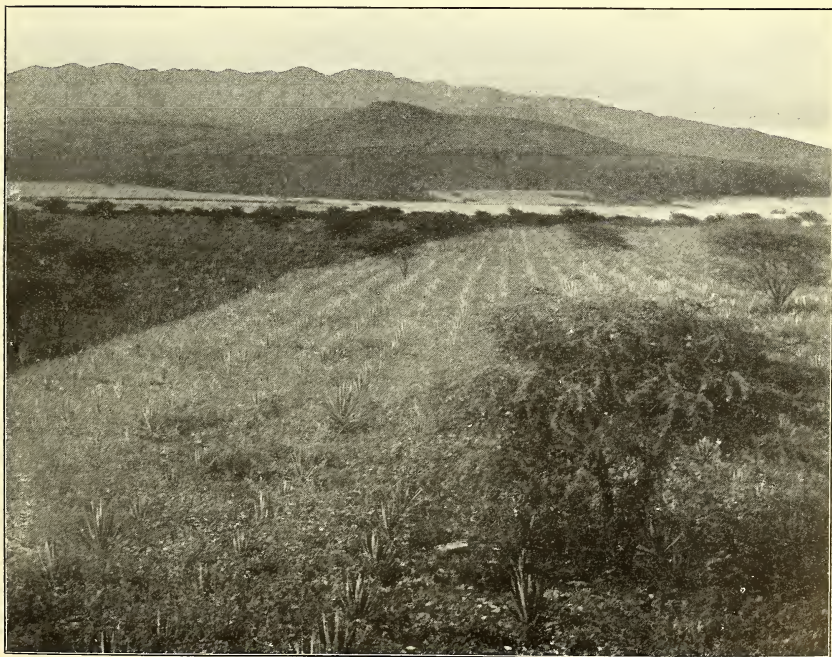


FIG. 2.—HAWAII STATION—PART OF 600-ACRE SISAL PLANTATION.

of one-ninth of an acre was secured from Judge W. L. Wilcox in one of the western suburbs of Honolulu. This field was one on which the root rot had been especially bad during the preceding season. The plat was drained, dug up, and given a heavy dressing of lime. Hules, or sets, from plants infected with root rot were planted in this field in October, 1901. When the plants were well established and commenced to grow, a fertilizer containing nitrogen, phosphoric acid, and potash was applied. Notes and observations were taken to show the progress of the experiment at weekly intervals, and examinations were made to determine the presence of the disease. An additional dressing of complete fertilizer was applied in the early part of 1902, and a dressing of nitrate of soda at the time the roots were commencing to enlarge in June. When the crop was harvested in September, 1902, the taro on this experimental plat was much larger and better than that grown on any of the adjoining lands. Although the field used was one on which there had been almost no crop during the previous season because of the disease, and furthermore, the experimental plat had been planted with diseased slips, the harvest showed a remarkable decrease in the number of rotted taro roots. Enough has been learned during this first season's work to indicate that the disease may be prevented by proper liming and fertilization of the soil on which the taro is grown, and by selecting for planting only those slips or hules which are free from the root-rot disease. A further experiment on the same land will be conducted during the coming season with a view to confirming the results of this preliminary trial.

GRAZING INVESTIGATIONS.

Some work has been done with a view to a systematic study of the forage resources of the islands. It is estimated that there are about 125,000 head of cattle on some 70 or more ranches throughout the islands, this number being exclusive of those kept solely for dairy purposes. The grazing lands constitute over three-fifths of the area of the Territory. The ranches vary from a few hundred acres to as much as 400,000 acres, and extend from sea level to the tops of the highest mountains—13,800 feet.

The grade of cattle carried on these ranges is very good. There are many pedigreed bulls and cows, representatives of all the best beef strains. Blooded stock has been imported from California and other States on the mainland, New Zealand, Australia, and Germany, and other European countries. On most of the ranches a considerable proportion of the cattle would compare favorably with the general run of herds in the range regions of the West and Southwest. The so-called "wild" cattle, which are the descendants of the cattle first turned loose in the islands a hundred years ago, are becoming fewer every year. All of the beef cattle raised in Hawaii are grass fed.

The fattening of stock in feeding pens or stables is nowhere practiced. The result has been that, while the local ranches are able to supply enough fat beef for the local market in good seasons when the annual rainfall is well distributed and consequently there is good feed, they fall far short of being able to do so in dry years, when feed is scant. While many ranchers have spent large sums of money in sowing seeds of imported grasses on the open ranges, the practice of growing a cultivated crop of alfalfa or clover to top off for the market has not been adopted. It is undoubtedly true that alfalfa can be grown almost anywhere from sea level up to 2,500 feet elevation, even where there is not sufficient water for irrigation, although the best results would be obtained where there was an abundant supply of water. As an example of what alfalfa will do in this climate, it is found growing on the old lava flows in North Kona, Hawaii, where seed had simply been scattered broadcast from horseback. Many of the lands now used only for grazing cattle are rich enough to warrant turning them into farm lands, either to be used by the ranchers in growing crops to fatten their stock or for the use of independent farmers.

An experiment has been planned on the lands of the American Sugar Company, Molokai, not only to attempt the cultivation of alfalfa and other forage crops on fields not under irrigation, but also to improve the range, which has been impoverished by overstocking. Preliminary arrangements have also been made to build a silo in the Kula district, on Maui, with a view to demonstrate that the corn fodder grown by the Japanese and Portuguese tenants in Kula should be fed to cattle instead of being burned. A study of the native and introduced grasses, clovers, and forage plants of Hawaii has been begun.

POTATO-BLIGHT EXPERIMENTS.

The Irish potato was formerly cultivated on an extensive scale in these islands. Within the last ten years a disease has become widely prevalent which has about ruined the industry. More properly speaking, there are two diseases, one the well-known black rot of the potato, the other a wilt disease which attacks the plant while in flower and causes whole fields to wither and blacken in a single day. The black rot may be combated and in a measure prevented by the use of Bordeaux mixture. The nature of the latter disease is not understood. A preliminary experiment was undertaken in January, 1902, to determine whether there were not some varieties of potatoes that would prove resistant to the black wilt disease. The use of a plat of land in Kula, Maui, in the center of the potato-growing district, was donated to the station by Mrs. Randall von Tempsky. On this land 45 varieties of seed potatoes grown in Maine were planted. Out of this large number one variety, the June, proved to be entirely resistant



FIG. 1.—HAWAII STATION—REGISTERED SHORTHORN COW, PUWAAWAA RANCH.



FIG. 2.—HAWAII STATION—WILD CATTLE, MOLOKAI.

to the black wilt. Two other varieties were partially resistant, while the remaining 42 sorts were completely destroyed at the time they commenced to flower. An experiment was undertaken at the same time to demonstrate the value of deeper plowing and better cultivation than is commonly practiced by the Kula farmers, who plow and cultivate only 3 or 4 inches deep. This preliminary work will be continued with the hope that definite and tangible results may be obtained.

COFFEE.

A preliminary study of the coffee industry was made in December, 1901, and March, 1902, with special reference to the possible extension of this industry in Hawaii. Coffee has been cultivated in these islands for more than seventy years. A grove of trees known to be over 60 years old is still growing in a thrifty condition in Kona, Hawaii, near Kailua. The annual exports of coffee from this Territory exceed 2,000,000 pounds, and the better grades, comprising a considerable portion of this amount, are sold on merit. Hawaiian coffees, especially those produced in Kona and Hamakua, on the island of Hawaii, are of excellent flavor, and are as distinctive as the finer grades of any other land. They have a flavor entirely characteristic, which differs from that of Java, Mocha, Brazil, or Guatemala varieties. Our coffees are mild and of high flavor, and the best grades sell at prices much above the average market quotations. The establishment of the Hawaiian coffee industry on a firm basis means a great deal for the future prosperity of these islands. The coffee belt lies above the sugar belt. The climate is unexcelled, and the coffee industry is as much a white man's occupation as is the cultivation of corn or wheat on the mainland. Any measure which will hasten the day when the arable land above the coastal sugar belt is utilized for coffee or other subtropical crops will work untold benefit for Hawaii economically, socially, and politically. From 10 to 20 acres of bearing coffee will return a net income to the farmer of more than double that area of wheat, corn, or cotton anywhere in the United States. There are half a million acres suitable for coffee cultivation in these islands—enough land to support 30,000 white families. As it is to-day the lot of white settlers, especially men of small means, is hard because of their isolation. Freight rates, both interisland and transoceanic, have in the past worked against Hawaii's minor industries in favor of the dominant one. With an increase in the white population, the natural increase in trade would tend to modify this inequality. A dozen families scattered here and there through 50 miles of country are sure to encounter great obstacles in the production and marketing of crops which are in themselves of insufficient volume to support either railroads or interisland steamers; but if this same 50 miles of country can become thickly populated the conditions of life can not help but be improved. The mutual

adaptability of coffee to the land and the land to coffee in Hawaii is not a subject for argument. True, coffee has been a failure in some districts, such as Oloa, from natural causes; but when one visits Kona, on the leeward side of the island of Hawaii, or Hamakua, Puna, and Hilo, on the windward, and sees a hundred miles of coffee, utterly neglected and uncared for, and yet refusing to die, but continuing to bear large crops year after year, the adaptability of the plant to the conditions is a surprise. Coffee grows anywhere above 1,000 feet and up to 3,000. Where the fields are given the best of care, with proper fertilization, yields of upward of 2,000 pounds per acre of marketable coffee have been obtained in both Kona and Hawaii.

In view of the importance of this crop to Hawaii I would earnestly recommend that a substation for the study of the crop in all its relations be established in a suitable location on one of the islands other than Oahu. For this purpose an appropriation of \$5,000 per annum would suffice. There are many problems connected with the cultivation, breeding, curing, fermenting, and marketing of coffee, as well as the diseases of the plant, which need elucidation. This station has already received several offers of land for such a substation, planted in coffee and provided with improvements, but has been unable to take advantage of any of them because of an insufficiency of funds to carry on the work. There is no doubt whatever in regard to the results to be attained. I respectfully submit that this matter should be given the attention which the subject deserves.

FIBER PLANTS.

Much attention is being paid to the cultivation of fiber plants in Hawaii. About 1,000 acres have been planted to sisal hemp, and about half of this acreage is in condition to harvest. Fiber extraction machinery has been installed on a plantation near Honolulu on Oahu, and the preliminary trials already made indicate that the fiber can be extracted from the sisal plant at a profit.

SISAL.

Sisal, or henequen, has been grown in Hawaii for about ten years, having been introduced and widely distributed for trial by the commissioner of agriculture and forestry under the monarchy. Wherever this agave has been tried it has shown marked adaptability to Hawaiian conditions. Sisal hemp thrives from the sea level up to an elevation of 2,500 or 3,000 feet. Although the claim has been made that this plant produces good fiber only when grown on calcareous soils at low elevation, I have seen many samples of fine fiber from plants grown at 2,000 feet altitude and at quite a distance from the sea. Sisal will grow with very little water on very poor soils, but it can not be controverted that far better results may be secured on fairly good land

with some water and cultivation. Irrigation of this crop when planted on rich land produces an enormous growth of leaves at the expense of fiber. The plant produces here a fine marketable fiber on upland soils which are not at all of the calcareous type, and while these fibers may sell for from one cent to half a cent per pound less than the very best grades, there is a very large market for them. There is a liberal margin of profit in sisal, but it is much like coffee in that those who attempt its cultivation must have sufficient means to stand the cost for the three or four years before the first crop can be harvested. There are fully 500,000 acres of land, now almost unused except for cattle grazing, which can be utilized in this crop. It is distinctively a crop for the leeward or dry side of the islands, for lands without an adequate supply of water for irrigation and sugar cane. There are wide stretches of such land on Molokai, Oahu, Kauai, Maui, and Hawaii.

MALINA.

Another fiber plant which thrives all over the group is "malina" (*Furcraea gigantea*), a plant reputedly introduced many years ago from Manila, and well known to the older Hawaiians, who used its fibers for making rope. Malina is even more widely distributed than sisal. It produces a fiber which, while less valuable than the best sisal or manila, finds a ready market for the manufacture of binding twine. No use is now made of this plant, but because of its having held its own for so many years in an uncultivated state there can be no doubt that anyone who would plant malina on a field scale would be well repaid for the expense involved. The best malina fiber sells within 10 to 20 per cent of manila and sisal.

OLONA.

The native Hawaiians in the days when they themselves manufactured articles to meet the daily requirements of the race utilized some of the native fibers for their ropes, twine, fish lines, fish nets, and for their garments. The very best of these was derived from the olona (*Tournefortia latifolia*). Unlike sisal and malina, olona grows best in regions of great rainfall, among the rainy forests on the windward slopes of the mountain ranges, mostly above 2,000 feet elevation. It is a low shrub or woody perennial herb, seldom more than 10 feet in height. Olona belongs botanically to the same natural order as the ramie plant. Its fiber is contained in the bast of the stems. Like ramie, the fiber is of remarkable fineness and strength, but unlike that of ramie, it seems to be entirely free of gum.

In the old days every chief had an olona plantation somewhere in the mountains above the lower edge of the forest. The fiber was not derived from wild plants, but from semicultivated areas where the fern and underscrub had been cleared away to permit the better develop-

ment of this shrub. The stems of the plant were cut partially through just at the surface of the ground and were bent over or broken down so that a multitude of slender shoots or suckers should be thrown up. At the proper season these rapidly developed osier-like shoots were cut, their bark stripped off, and by the use of crude instruments the long, fine fibers were separated from the bark. The remarkable strength and fineness of this olona fiber and its resistance to the action of sea water caused it to be used for deep-sea fish lines and nets. At a later date olona entered into foreign commerce, being used for hand-made fish lines, life lines, and for similar purposes where great strength with lightness was desired. Certain of the islanders' taxes were paid in olona fiber, and it is said that this trade in olona was a source of considerable profit to the king and his chiefs.

Within recent years, through the development of trade with outside lands, olona has fallen into disuse, and the Hawaiians of the newer generation have lost all knowledge of its method of extraction and manufacture. It is possible that this fiber can be made far more valuable in the textile arts than ever before. Its cultivation does not require a large expenditure. The yield of fiber per plant and per acre is quite large, and the development of a market for it would bring into immediate utility much of the forest land above the sugar belt without entailing the destruction of the forest. The cultivation of olona fiber, if only a suitable market can be found for it, will thus mean a good deal for a zone where there are now almost no crops of agricultural value.

OLONA FIBER.

The following account of the occurrence and preparation of this fiber was supplied at my request by Dr. N. Russel, of Olaa, Hawaii:

Olona is a native Hawaiian name of a single botanical Hawaiian species of plant of the Urticaceæ or nettle family. In Hillebrand's *Flora of the Hawaiian Islands* we find a technical description of the plant, which is accompanied with the following footnote: "In deep ravines on all islands, but by no means common. It is the 'olona' of the natives, which yields a fiber highly prized for tenacity and durability, and is chiefly employed for making fishing nets. * * * The species, as a rule, is dioecious."

Some fifty years ago about 1,000 natives were living on the margin of the virgin forest and pahoe-hoe rock along the trail connecting Hilo town with the crater of Kilauea, island of Hawaii, in a spot corresponding to the present 22-mile point of the Volcano road. Making of "kapa" (native cloth) out of "mamake" bark (*Pipturus albidus*), of olona fiber for fishing nets out of *Touchardia latifolia*, and capturing "O-U" birds for the sake of the few precious yellow feathers under the wings, of which luxurious royal garments were manufactured—those were the industries on which they lived.

For the reasons common to all the native population of the islands, viz, the introduction of new germs of disease—syphilis, leprosy, tuberculosis, smallpox, etc.—this settlement gradually dwindled away, and in 1862 the few surviving members migrated to other localities. At present only patches of wild bananas, taro, and heaps of stones scattered in the forest indicate the places of former habitation and industry.

I have heard, however, that as late as the seventies Kalakaua still levied a tax in olona fiber from the natives of Puna and Olaa districts, which fiber he sold at high prices to Swiss Alpine clubs, who valued it for its light weight and great strength.

Touchardia grows abundantly in Olaa forests, presenting a kind of a natural plantation. It very successfully holds its own in competition with ferns and other elements of the undergrowth in the shade of "ohia" trees (*Metrosideros polymorpha*). The deep shade, very porous soil, considerable moisture, with a yearly rainfall of 180 inches pretty evenly distributed, are the natural conditions. By removing some of the undergrowth, scattering seed, and probably by planting cuttings, the number of plants on the same area could be greatly increased with but very small expense. Since plants of medium age (about 18 months old) supply the best fiber, natives in gathering used to turn down the older ones with the foot, laying the whole plant on the ground to force new shoots and sprouts.

MANUFACTURE.

I was familiar with the plant and its properties for years, but did not pay any further attention to it as a possible object of industry for the reason that to all appearances the same difficulties in mechanical extraction of fiber will be met as in the case of ramie, for which no satisfactory machine has been found. Recently my interest in the matter was again aroused by Mr. Jared G. Smith, of the Hawaii Experiment Station. Considering that Touchardia seems to be free from resinous matter, upon his suggestion I decided to examine the subject more in detail. For this purpose an old native, born and raised in the settlement above mentioned, was interviewed. Together with him I proceeded into the forest along 22 miles side trail. In my presence he picked the plants, stripped them of the bark, and with his own olden tools manufactured the sample of fiber.

My object was to ascertain what kind of plants he selects, and to see the primitive method of manufacture, with the idea that this method might furnish some suggestions for the construction of the machine. We had hardly made a dozen steps in the woods along the 22-mile trail when a rich harvest of Touchardia was found. We found both male and female plants that could be distinguished only by inflorescence. Whereas male flowers are situated on relatively strong, repeatedly forking cymes, growing out of the base of the leaves, female ones look like so many flattened lumps of green dough planted at the base of the top branches. Both plants are taken indiscriminately. Careful discrimination is made, however, in regard to the age of the plant; neither too young nor too old ones are taken. The bark of old ones is somewhat knotty, woody, and short jointed, and, as I have mentioned, such plant is turned down to the ground to force it to give new shoots. The best stems are not thicker than the finger, about one year and a half old, with the bark of a chocolate-brown color, with distanced scars of former leaves, straight and high (8 to 10 feet), devoid of leaves except on the top. Such stems are cut with the knife near the root and below the crown. Their bark strips easily as a whole from bottom to the top. The ribbon obtained is hung over the neck of the gatherer. There is also a plant with the leaves very much like those of Touchardia, the "hopue"; but this one generally grows to a large sized tree, has different flower, and light-grayish color of the bark. Neither previous soaking nor drying are resorted to before the extraction. The bark is used raw.

The implements used are: (1) A wood board made of "naou" tree, characterized by its dark color, hardness, compactness, evenness, and absence of knots. This board is about 6 feet long by 2 to 3 inches wide. It has a very light curve in both directions—in width and length; is wider at one end and obtusely pointed at the other. (2) A plate of fish bone of "honu" fish, about 8 inches long by 2½ wide, and is also slightly curved in both directions. Its lower margin is sharpened under 45° like the edge of a chisel.

The process of manufacturing is as follows: The "naou" board is fastened on the ground with rocks at the narrow end to prevent any forward sliding, the curved surface uppermost. The broader end is a little elevated by another piece of rock. The board is moistened with water. A ribbon of bark from one plant is taken. Its bottom end is first fastened by treading on it with the toe of the right foot, the top end raised vertically by the left hand, so as to tightly stretch the band. Holding the fish plate by the right hand in its middle, the sharp end of the bone is passed upward along the inner surface of the ribbon, which operation is intended for flattening the curled ribbon and taking off the slimy substance covering the inner surface. Then the ribbon is stretched horizontally upon the naou board, the bottom end toward the wider end of the board and the operator, and held tightly to it by the two fingers of the left hand, the outer surface of the bark upward, the inner sticking to the board. Then the fish plate, held in the right hand by the middle at 45°, with its sharp end downward and forward, squeezing the ribbon between the tool and the board, is repeatedly passed toward the pointed end of the board, by which motion the flesh is scraped off, leaving a ribbon of fiber. From one to two minutes are required to free the bark of one plant. The operation of scraping is easy, the fiber evidently being located on the inner surface. The fiber thus obtained is dried in the sun.

Besides manufacturing fishing nets, natives used to make of it the best of their fishing lines. I am told that whalers in former times paid high prices for *olona* for making lines for whales. There is an old native in Hilo who still uses the line that was made and used by his grandfather.

FRUITS.

Although there are large quantities of fruit imported from the mainland, especially those of the temperate zone, there are some which here attain a degree of perfection not approached in any portion of the United States. We have also some fruits which are distinctively tropical, a market for which may some day be developed on the mainland.

PINEAPPLES.

A pineapple cannery is now in successful operation on the lands back of Oahu plantation. Two new companies have been formed at Wahiawa, Oahu. The total area planted is about 1,000 acres. This fruit seems to be especially adapted to island conditions, and there is still a great deal of land available for pineapple cultivation.

I append a paper by Hon. Byron O. Clark, of Wahiawa, relating to this new industry:

Pineapples seem to be one of the crops especially suited to our local conditions, having no destructive insect pest, imported or native, to prey upon it; thriving through drought, producing even better quality of fruit than during wet seasons; easy of propagation and cultivation and responsive to good culture, which, with a certain amount of fascination that attends the production of all tropical fruits, place it well up among the popular fruits destined to figure in the horticultural history of Hawaii in the near future.

The growing demand for the fruit on the mainland and for ships' supplies, both in the fresh and canned state, leads me to consider it a safe and profitable crop, as well as being otherwise suited to the conditions of the small farmers of the islands. With

the advent of canneries here, this one industry can be made a source of revenue—through the employment given in growing and packing the fruit—sufficient to assure the future prosperity of this colony.

It is very gratifying to be able to speak hopefully of this industry, as we hear so much of a pessimistic tone regarding the possibilities for the small farmer making a living here. It now looks as if we would soon be able to give ocular demonstration so convincing that the class of people who always beset new countries, belittling the opportunities and discouraging home makers, will have to find a new topic to “harp” on. For even with one anchor crop (and I believe there are other industries, including sugar cane, that will be developed into paying industries suited to the small farmer) the prospect is good.

If I may be allowed to digress, I wish to state as my candid belief that in less than five years we shall hear less of the cry, “small farmers can’t grow cane,” for they not only can but will, if given a chance, and will be the salvation of the sugar industry from the disaster that pessimists are endeavoring to claim for it.

As to pineapple culture—it is much like other branches of horticulture—there are “many men of many minds,” and consequently considerable divergence of opinion as to methods. My own experience for the past four and a half years convinces me that when land is not limited to very small tracts, wide planting between the rows—in order to permit cultivation by horse instead of hand labor—is best. While one gets a lesser number of plants on a given area, it is much easier to get among them for hoeing, which is limited to the immediate vicinity of the plant, and for harvesting the fruit and removing the suckers for new plantations. Then, there is a better chance for perfect development, and the cropping period of the land certainly will continue longer with 3,000 plants per acre than with three times that number, as is frequently done by the advocates of close planting. I have demonstrated to my satisfaction that the breaking of the fruit from the stem is prevented by wide planting. I think it is caused by insufficient nourishment, and instead of close planting preventing it, as is claimed, it aggravates the trouble, unless the plants are so very close together that the fruit is held in place, and such planting soon leads to deterioration of the quality of the fruit. You can no more continue taking three fruits from the space that one needs with the pineapple than you can with the peach, orange, or other fruits. Excessive crowding is always at the expense of quality if not of quantity, and generally of both when net profit is figured. Then, too, crowding of any plant, leading to weakening of the vitality, encourages the ravages of insect pests. With the close, crowded condition of many plantations it is difficult to get among them for applying insecticides, and the dense, crowded mass of plants becomes a veritable hotbed for all kinds of scale and for mealy bugs, if they once get a foothold.

FIGS.

Figs thrive luxuriantly in all the districts of the islands below 5,000 feet elevation. They seem especially thrifty in the leeward regions, such as Kona, Hawaii. They bear large crops of fruit of uniformly fine quality from January to August. There are no destructive diseases, and few pests other than the honeybee and the mina bird, both of which are fond of the ripe figs.

A fig cannery would find in many districts a sufficient supply of fruit to keep it in operation six months in the year. Such an enterprise would give the growers a local market, whereas now there is no market, since ripe figs do not bear shipping. In parts of Kona, Hawaii, the

enormous crops of fruit borne by the trees are either allowed to rot or are fed to pigs. I believe that here is a small industry which will prove lucrative both to the grower and to the canner.

PAPAYAS.

The papaya is well known to Florida horticulturists, and to a certain extent in the New York fruit markets as well. As a breakfast fruit it has few equals. Not only is it excellent for the table, but it also has medicinal value. The leaves, seeds, green fruits, and the milky juice of all parts of the plant contain a vegetable pepsin "papain," which when properly prepared is of medicinal value. There are two general types of papayas grown in Hawaii. One with elongated fruits was introduced from Ceylon within recent years. The more common variety has fruits which are oval, often as large as a medium sized winter squash. The papaya grows well in almost any soil or in rocks where no soil is to be seen. The fertile trees begin to bear when 8 to 12 months old and fruit continuously for two or three years.

Papayas are a very good money crop, because the fruits ship well and bring a good price in the local markets. They also begin to make some return for the investment earlier than in the case of most tropical products. Fine jams are made from ripe or partly ripe papayas. A Honolulu manufacturer prepares from the partially ripe papaya a very excellent candied fruit, which is used locally as a substitute for citron. The powdered seeds are especially useful in treating cases of chronic indigestion. The ripe fruits are a good feed on which to fatten hogs. So it will be seen that the numerous uses of this fruit make the plant a good one for cultivation by men with limited areas of land or small means.

GUAVAS.

The guava is so abundant that it has become almost a curse in Hawaii. It is very difficult to rid land of guava bushes because of the creeping underground stems and roots. However, this plant may be considered an index of rich land, as it grows only where the soil is of the finest. Guavas bear from two to three crops per annum, or in some cases fruit continuously. But little has been done with this tree in Hawaii, but a few cultural experiments indicate that if the guava was given orchard cultivation, with careful pruning, the quality of fruit could be easily improved and the yield much increased.

The demand for guava jellies and guava jams is on the increase in the United States. There are many localities where the crop which now rots on the ground might be gathered at little expense and used for the manufacture of these delicious articles. Besides the fruits, the wood is valuable for making charcoal and the bark is used by local tanners.

FIG. 1.—HAWAII STATION—BANANAS.

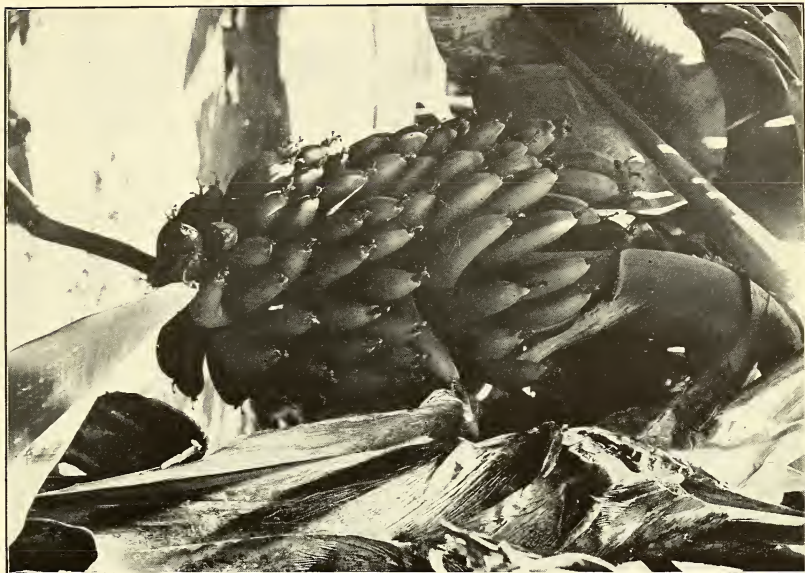


FIG. 2.—HAWAII STATION—ALLIGATOR PEARS.





FIG. 1.—HAWAII STATION—ORCHARD PLANTATION, STATION GROUNDS.



FIG. 2.—HAWAII STATION—3-YEAR-OLD LEMON TREE, PUNWAAWAA RANCH.

MANGOES.

A great variety of mangoes is cultivated in the Hawaiian Islands. The tree is one of the most beautiful, because of its dense foliage and symmetrical form. It thrives from sea level up to about 1,500 feet elevation, and must be planted where partially protected from the full sweep of the trade winds. The ripe fruits are often of excellent quality, the flavor being more pronounced than in many other tropical fruits. They are also eaten cooked, both green and ripe, and the chutney varieties are pickled. Elsewhere in the Tropics mangoes are given orchard cultivation, and the soil around them is fertilized after a crop of fruit has been harvested. The tree grows best in well-drained soil, and if the tree is made to rest and ripen its wood it will yield annual crops. The fruit is best when ripened off the tree. The mango ships well. It is a promising crop for cultivation on a large scale in Hawaii for shipment to the mainland.

ALLIGATOR PEAR.

The "avocada," or more commonly called "alligator pear," is a fruit which grows well in sheltered localities up to 2,000 feet. The tree is even more susceptible to damage by high winds than the mango. The fruit is eaten as a salad, with salt, vinegar or lime juice, and pepper. It is considered very healthful. There is much difference in the quality of the fruit in different varieties, as also in the form and size. The local markets consume all the alligator pears offered. When of good quality the fruits bring high prices. They ship well in cold storage, and the mainland markets might well be catered to by Hawaiian orchardists.

GRAPES.

Grapes are grown for the local market, and in isolated sections for wine making. Out of 50 varieties which were experimented with some years ago, the Isabella seems to be best adapted to island conditions. Other varieties have been grown with success. The trellis system of growing grapes is the only one used at present. Grapes sell in the markets for from 10 to 15 cents per pound.

LIMES.

Limes thrive in the upper gulches and upper valleys of all the islands. The fruits are large, smooth, and thin-skinned and full of juice. Unlike island oranges, they are comparatively free from skin blemishes. The trees bear the year round. Limes sell for 15 cents a dozen in Honolulu.

PEANUTS.

Peanuts were cultivated at one time principally for the oil. At present they are grown to a limited extent to partially supply the local demand as a nut. The crop is well adapted to many of our soils. While the nuts are small they are sweet, and by the introduction of new varieties possibly a larger nut could be secured.

ABANDONED INDUSTRIES WHICH DESERVE ATTENTION.

COTTON.

Cotton was introduced into the islands in the early part of the last century, samples of it being sent to China by Kamehameha the Great. The staple was of good quality, and the fabric made from it was strong and heavy. The plant in this latitude is a perennial. The varieties that have been grown here are Sea Island, Georgia, and Peruvian. Cotton was an article of export during the years of the American civil war.

CASTOR BEAN.

The castor-bean plant has been growing in the Hawaiian Islands for so many years that it is now a roadside shrub. The plant is here a perennial tree, often reaching the height of 30 feet with a trunk 12 to 20 inches in diameter; whereas, in the temperate regions, it is an herbaceous annual. It can be seen at almost any elevation and in most localities. Its cultivation for commercial purposes has not received much attention.

On good soil an acre of castor-bean plants will yield 2,500 pounds of beans annually. The commercial life of the plant is from five to seven years, and as yet no serious pest has appeared to injure its growth. There is a ready market for the beans in Honolulu at from \$50 to \$60 per ton. Lately the industry has been receiving more attention from farmers. One fully equipped mill for making the oil from the beans has been erected. The oil is used for lubricating purposes, is of good quality, and sells at from 90 cents to \$1 per gallon. Castor beans and papayas grow well together. The combination of these two trees in an orchard reduces the cost of harvesting, as both crops may be gathered at the same picking. This plant grows on a great variety of soils, and much uncultivated land might well be planted to castor beans.

PIA, OR CASSAVA STARCH.

The manufacture of starch from the manioc plant is an industry which has attracted the attention of farmers in the Hawaiian Islands for a number of years. This starch, known locally as "pia," is highly esteemed by the natives both for laundry and cooking purposes. Pia starch sells in Honolulu for from 7 to 10 cents per pound retail. The



FIG. 1.—HAWAII STATION—COTTON PLANTS.



FIG. 2.—HAWAII STATION—CASTOR BEAN TREE, 25 YEARS OLD.

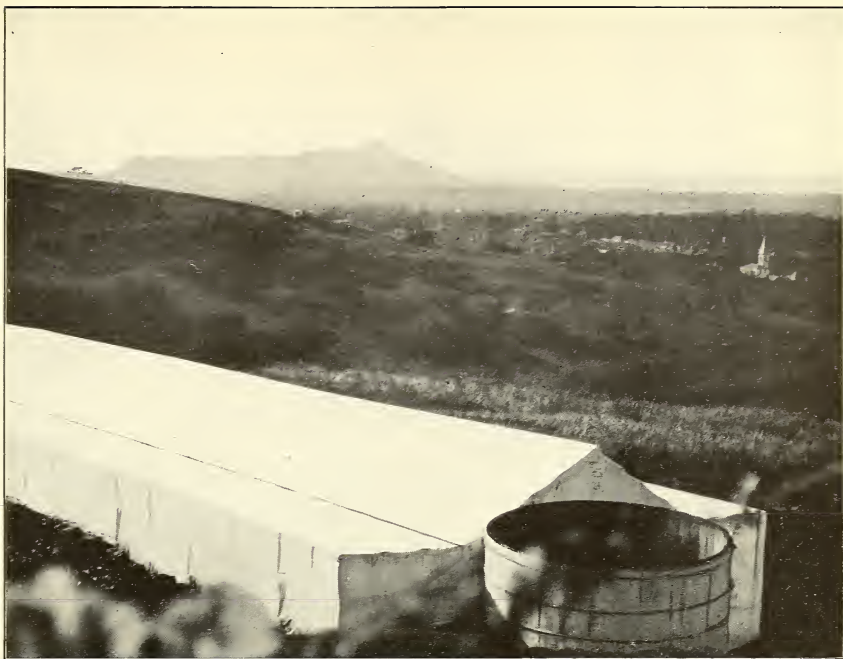


FIG. 1.—HAWAII STATION—NEW PLANT HOUSE, MUSLIN COVERED.



FIG. 2.—HAWAII STATION—INTERIOR OF NEW PLANT HOUSE, SHOWING CONSTRUCTION.

demand is constantly increasing. The adaptability of the soil and climate of the Hawaiian Islands to its culture would indicate that the demand can be indefinitely supplied.

The processes of manufacture are generally primitive. In the method commonly employed the root is washed and grated by hand graters. The pulp thus made is placed in water, the mass thoroughly stirred, and the whole allowed to settle. The water is then drawn off and the residue, which is starch, is washed and dried. The refuse from the starch mill is fed to pigs. It is a fattening food and contains considerable nourishment. The manioc plant thrives on all the islands of the group. It does not require the attention that many crops do, and it is comparatively free from pests. The chief obstacle in the development of this industry at present seems to be the lack of modern mills.

ENTOMOLOGICAL INVESTIGATIONS.

The annual loss in this Territory through the depredations of insect pests far exceeds the average of other districts of the country. The vast number of injurious species present here is one of the greatest obstacles in the development of Hawaiian agriculture. The large areas of uncultivated lands give the pests unrestricted opportunity to develop in numbers sufficient to discourage the cultivation of plants in the vicinity of such areas. A more complete cultivation will help to solve this side of the problem. The insects have been introduced from abroad, where in many cases they have been kept in check by climatic conditions and their natural enemies. Here, relieved of these natural checks, they have multiplied in unlimited numbers and the small area of the islands has permitted their rapid spread.

The fruit industry is not at present developed to any importance. The greatest injury occurs to field crops. The general use of insecticides is nowhere practiced in this Territory. Precautionary measures are, in the main, the most important in the cultivation of field crops. These are thorough and clean cultivation, proper time of planting, the use of fertilizers to produce a vigorous growth, the clearing away and burning of all rubbish, and the keeping down of all weeds in the vicinity of cultivated places. When a pest is established and the plant is not able to resist the attack, the use of insecticides must be employed.

An immense amount of scientific work has been done on the Hawaiian insect fauna, but as yet the only steps taken to check the ravages of the injurious species have been the introduction of their parasitic and predaceous enemies. This is valuable work and highly desirable, but it is not certain that an introduced parasite will confine itself to one special host.

The introduction of the parasitic and predaceous enemies of our injurious insects is very important, and the Territory is especially

fortunate in having in its employ experts working along this line. The introduction of such species, together with a more extensive cultivation, will bring the number of herbivorous insects down to a normal ratio and render the use of precautionary measures and insecticides more feasible. Where the pests occur in almost countless numbers, as they do in the center of great areas of uncultivated lands, the task of combating them seems hopeless. With the cultivation of greater areas and with the presence of natural enemies, the number of injurious insects will be greatly lessened. Wherever the cultivation of plants favors the development of plant-feeding forms and destroys the natural breeding places of their enemies, artificial means must be employed to counteract the effect. For this purpose the application of insecticides has come into general use throughout the United States and other countries.

This station is supplied with the standard remedies for insect pests, and will endeavor to adapt their use to the local conditions. The frequent local rains will make it necessary to spray more often than in other countries and demand the use of mixtures not easily washed away. The absence of long seasons of extreme cold or dryness will force the operator to be more persistent in his efforts, because of the lack of these natural aids. In the spraying of trees, the fact that they remain in leaf throughout the year will prevent the use of the more active insecticides applied successfully during the winter in the temperate zone. These and other conditions must be considered and recommendations made accordingly. The question of legislation has been suggested in combating some of the more serious pests in certain districts of the islands. This is not a political question, but rather one of education.

As has been already stated, the damage to the field crops is the most important loss. The aphid all but ruined the 1902 crop of corn on the island of Maui. It was preyed upon by two of its natural enemies, a ladybird and the aphid-lion, yet in certain fields the leaves looked as if a fire had swept over the place. Precautionary measures were prescribed. Corn had been planted in this district year after year for the past 20 to 40 years without change of crop or seed. Deep plowing had not been practiced and the use of fertilizers to strengthen the plant to resist the attack had not in any case been employed.

Several small farms on the island of Hawaii were abandoned last year because of the cutworms (three species of Noctuidæ). These pests are widely distributed over the islands. It is a saying among the farmers that they "can raise four crops a year—one for themselves and three for the cutworms." On limited areas it is believed that these pests can be kept in check.

A fly is doing great damage to the cucurbits by stinging and depositing its eggs in the young fruit. The larvæ on hatching burrow into

the tissue, causing decay. As a result a good watermelon brings from 50 cents to \$1 on the fruit stands of Honolulu.

Stockmen are greatly troubled over the presence of the horn fly. Cases have been reported where death of the animal has been the result of its attack, but there is no doubt but that lack of water and the proper amount of food helped to bring the fatality about.

Several hundred thousand dollars' worth of sugar cane is destroyed yearly by certain pests of that plant. Most of the damage is wrought by a borer, the larva of a beetle (*Sphenophorus obscurus*). -

The trees of the Hawaiian Islands suffer continually because of the presence of an unusual number of scale insects, plant lice, and mealy bugs. One species of the latter pest (*Dactylopius* sp.) is at present doing great injury to the alligator pear, or avocada, in the vicinity of Honolulu. Many trees have died and all are injured to a greater or less extent. The application of kerosene emulsion has been used with success in several instances and will be advised as a remedy, together with proper pruning and cultivation.

A most destructive pest to grapes, roses, and all shrubs in general is a beetle living on the foliage, called, on account of its injury to the roses once grown here in abundance, the Japanese rose beetle (*Adoretus umbrinus*).

The list of household pests is a long one and includes ants, cockroaches, termites, silverfish, clothes moths, and mosquitoes. The number of such pests here in the Tropics is unusually large. The most serious of this class is the mosquito. The only way comfort can be obtained is by screening the houses. This method and the burning of pyrethrum are the only measures taken against this pest. The measures so successfully carried on in certain parts of infested regions of the United States in exterminating the mosquito during the immature stages of growth will be advocated here.

The station has purchased for the use of this Department the standard works on economic entomology and procured the various publications of the Division of Entomology at Washington and the State experiment stations of the country. A laboratory fitted with the necessary apparatus to carry on breeding experiments is now a part of the equipment. Microscopes and other apparatus, together with collecting supplies, have been purchased, and a collection of Hawaiian insects is well under way. Several styles of spray pumps, thought to be especially suited to the work, have been purchased. One pump and outfit has been donated to the station for trial. These will be given a thorough test and reported upon. The entomologist is also supplied with a photographic outfit to be used in obtaining illustrations for publications and for lantern slides for use at farmers' institutes and in lectures to illustrate the life histories and work of the insect pests.

DISTRIBUTION OF SEEDS.

During the fiscal year 1901-2 many seeds have been sent out by this station for trial. These were mainly of various forest trees having some valuable economic quality, such as the cork oak, pistache nut, carob bean, divi-divi, teak, and some of the Australian eucalyptus species not already in common cultivation. A collection of vegetable seeds received from the Bureau of Plant Industry was distributed in small lots among a number of the common schools of the Territory for use in the local agricultural nature-study work. Much has been done in getting seeds of tropical and subtropical economic plants for the use of those who wished to try them.

CORRESPONDENCE.

So far as possible, assistance has been given to all who have applied for information in regard to agricultural problems in this Territory. This has entailed much letter writing. About 500 such communications have been answered during the year, and as no provision has been made for clerical help, much time has been given to this side of the work by the special agent in charge and his assistants.

WORK FOR OTHER DEPARTMENTS.

At the request of the commandant of Camp McKinley, acting through the Secretary of War and the Secretary of Agriculture, 1 acre of ground on the lower portion of the station has been set apart for a propagating nursery for starting trees to be used at the new military post west of Honolulu. This ground was plowed and water pipes laid. The cost of labor and other expenses in connection with this nursery are borne by the War Department, but the selection of the trees and plants and the general supervision and direction of the work has been carried out by the special agent in charge of this station.

The agriculturist of the station has received many calls for assistance from the collector of customs and the collector of internal revenue during the year, and has made many chemical and technical examinations of drugs, liquors, cereal products, and textile fabrics for these two offices.

IRRIGATION.

On January 1, 1902, the special agent in charge was instructed to investigate and prepare a report upon the cost of pumping water on the various sugar plantations on these islands. Pursuant to these instructions, letters of inquiry were directed to plantation managers, and a tour of inspection was made to the Baldwin group of plantations on Maui and the principal plantations on the island of Oahu. A report was prepared and submitted embodying points relating to the

following subjects: The chief hydrographic features of the islands and the source of the water supply; the relation of forests to irrigation; the classes of pumps used, and complete details of the pumping machinery and cost of operating the same on Oahu and Ewa plantations on the island of Oahu, and Haiku, Paia, Hawaiian Commercial, and Kihei plantations on Maui.

COLLECTIONS.

An herbarium of both native and introduced plants has been begun. About 1,500 specimens, mainly collected on the experiment station grounds and in the environs of Honolulu, are now in this herbarium, and others are being added as opportunity allows.

THE FARMERS' INSTITUTE OF HAWAII.

The farmers' institute work was started in Hawaii in January, 1902. Through the efforts of the officers of the United States experiment station in Hawaii, a meeting of those interested in such a movement was held on the evening of January 25 at the residence of Mr. B. O. Clark, at the Wahiawa colony, Oahu. At this meeting the following officers were elected: President, Jared G. Smith; vice-president, T. F. Sedgwick; secretary-treasurer, D. L. Van Dine. The purpose of the meeting was to organize a permanent society to help the farmers throughout the Territory and encourage the founding of permanent homes in Hawaii.

The members of the newly formed institute were encouraged to proceed with their plans by the following letter from the governor of the Territory:

EXECUTIVE CHAMBER, TERRITORY OF HAWAII,
Honolulu, January 24, 1902.

THE FARMERS' INSTITUTE.

GENTLEMEN: It is with great pleasure that I have learned of your intention to organize a farmers' institute upon a permanent basis. It is an enterprise which, if perseveringly conducted, can not fail to be of great benefit to the farming interests of the Territory in distinction from sugar-planting interests. Your success will doubtless stimulate the formation of similar associations in other parts of the islands.

I notice in the newspapers some doubt expressed as to the practicability of profitable farming in the Territory. I have no doubt on the subject; and it is by such organizations of farmers' institutes, intelligently and enthusiastically carried on, that the success of diversified agriculture will be most effectively promoted.

I recognize the probability that general farming here must develop slowly. Individuals here and there will succeed because of intelligent and skillful cultivation of the soil and a careful study of the markets. Farmers' institutes will promote such cultivation and such study of the markets among the whole farming fraternity.

I need hardly remind you of the extent to which our political future depends upon the growth of a farming class in these islands, living on and making their living from their farms. If we fail in this, and the agricultural work in the Territory shall be confined to large estates cultivated by a floating element of cheap laborers having no interest in the soil, the prospect of building up a citizen population of a conservative and intelligent character will be poor indeed.

I wish to call your attention to the intention of the government to hold an exhibition of agricultural, horticultural, and floral products in the month of July of this year, and to invite your members to compete in such exhibition.

I wish your enterprise all success.

Very sincerely,

SANFORD B. DOLE.

This society is not the first one to be organized for the promotion of agriculture in Hawaii. Such organizations have been in existence for the past half century. For one reason and another they have passed out of existence, the most important reason being perhaps that the country is dominated by one great industry, the raising of cane, beside which the lesser industries have had little attention or encouragement.

For the past four years persons interested in such a work have sought to establish an organization on the plan of the farmers' institute, but each year have met with failure. This year has seen the first successful attempt to bring the farmers of the Territory together and unite them in one effort to build up and broaden Hawaiian agriculture.

The idea of institute work has been well carried out; the informal meeting of the scientific and the practical agriculturist on a common ground in order that the experimenter may learn the difficulties and needs of the latter and the practical farmer may learn the underlying principles connected with the operations of the farm and field and gain a solution of the problems which daily confront him; in other words, to learn how to apply to his work the results of scientific investigation.

Six sessions of the institute held during the year have been attended by members of the station staff, three at the Wahiawa Colony, Oahu; one at Honolulu, and two on the island of Hawaii—at Hilo and at Mountainview. While in each case the meetings were local in their scope, especially the discussions, yet the papers presented treated of the subjects in a way applicable to the Territory in general. The discussions were made the important part of each programme.

Subjects on which papers were prepared by men best fitted by experience to write them are: Forage crops; the relation of the experiment station to the farmer; the pruning and cultivation of fruit trees; the possibility of the agricultural development of the different farming districts of the islands; stock raising; the castor bean; pineapples; potatoes; the fertilization of fruits and vegetables; vegetable gardening; and the possible products for export.

Since its organization the Farmers' Institute of Hawaii has had a steady growth. Men not directly connected with agriculture, as well as the latter class, but interested in the agricultural development of the Territory, have placed their names on the roll of active members. The interest shown indicates that the society is permanent and in the future will be a factor in the promotion of agriculture in the islands.

As a result of the preliminary meetings held at Hilo and Mountain-view, on the island of Hawaii, permanent organizations holding monthly meetings have been formed at each of these centers.

CLIMATE.

While the temperature of the Hawaiian Islands is as a whole quite uniform, there are local conditions that give the country many variations. The island climates have been classified by Prof. C. J. Lyons, Government meteorologist, as follows: (1) The weather side trade-wind exposure; (2) the lee side trade-wind exposure; (3) the strong trade region; (4) the lee side land and sea breeze; and (5) the weather side land and sea breeze.

A few hundred feet altitude, an exposed position to the wind, a few more inches of rain, or a few degrees in temperature are sufficient to cause a different climate. Some localities have much wind and rain, others wind without much rain, and still others rain without much wind. The valleys, plains, plateaus, gulches, and mountains all have a climate peculiar to themselves.

The general climate of the islands is said to be due to the trade winds and the phenomena caused by the mountains, which affect the rainfall.

RAINFALL.

The rainfall is extremely variable. In some sections the average for the year may not be over 20 inches, while in others it is almost 200 inches. Between these extremes there are many variations. Along the coast lines of Oahu and Hawaii the variation is from about 20 inches at Kawaihae to 127 at Waiakea, a variation of over 100 inches at not greatly different elevations.

The amount of rainfall does not necessarily increase with the elevation, although it frequently does so. The effect of elevation on increased rainfall is well shown along the mountain slopes of Haleakala, Maui. Starting at Kahului, at sea level, with an annual rainfall of 14.63 inches, the total of precipitation increases rapidly with the elevation, and Puuomalei, at an elevation of 1,400 feet, has a rainfall of 59.29 inches. This change takes place in a distance of about 10 miles. Beyond this point there is a decrease in the total precipitation toward the center of the island. On the island of Hawaii there is an increased rainfall from Hilo toward the summit of the volcano Kilauea until an elevation of 1,650 feet is reached. Here the precipitation is 177.98 inches. At Volcano House, where the elevation is 4,000 feet, the annual rainfall is but 75 inches. Important variations within short distances at nearly the same elevation are noted. As an example: At Kapiolani Park, a suburb of Honolulu, with an elevation of 10 feet, the rainfall is 22.94 inches, while at Honolulu, elevation 15 feet, it is

29.79 inches. The distance between these two points is not over 3 miles.

Frequent light local showers are characteristic of the Hawaiian climate. They often seem to come from a clear sky, and it frequently happens that one locality may be drenched by a sudden shower while a few hundred yards distant there has not been a drop.

WINDS.

The prevailing wind is the northeast trade. It blows on an average 260 days in the year and is one of the chief agents in making the climate of Hawaii what it is. The trade winds being strong and cool, not only moderate the heat, but influence the health of the inhabitants of the islands. Devastating winds are of rare occurrence. There are light sea breezes and occasionally a "kona," which is a severe southwest wind. November is the special season for the kona, which in some sections causes considerable damage. The rainy season extends from November to March. Electrical disturbances are occasional, but not severe.

TEMPERATURE.

The temperature is not so variable as the rainfall, but a few degrees either cooler or warmer in this latitude make a great difference in the feeling and comfort of the individual. The following figures show approximately the variation in temperature according to the elevation at the several stations on the island of Hawaii:

Range of temperature in Hawaii.

Elevation.	Temperature.		
	Maximum.	Minimum.	Average.
	<i>Degrees.</i>	<i>Degrees.</i>	<i>Degrees.</i>
100 feet	84	64	73
585 feet	85	66	74
2,720 feet	82	57	70
4,000 feet	75	65

At Honolulu the average temperature is 74° F., with extremes of 88° and 54° and a daily range of 11°. Occasionally the mercury goes 1° or 2° higher or lower. The daily range usually increases toward the higher elevations, where it approaches that of the temperature of colder countries, ranging from 16° to 20°.

The average relative humidity is 72 per cent, which is low for the Tropics, and to this fact may be attributed much of the salubrity of the climate.